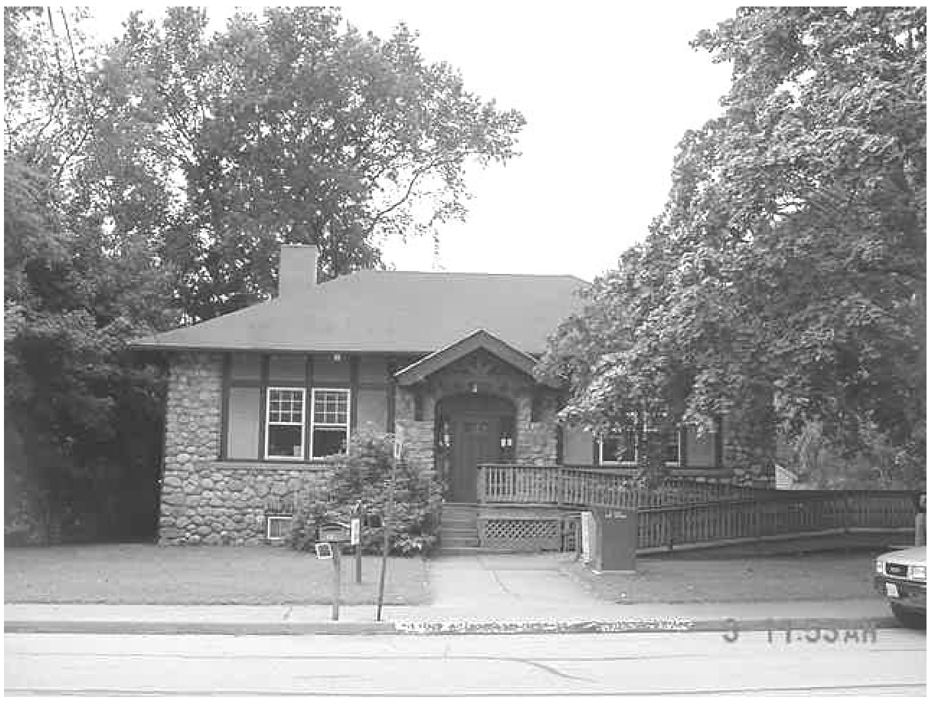
INDOOR AIR QUALITY ASSESSMENT

Dighton Public Library
375 Main Street
Dighton, Massachusetts



Prepared by:
Massachusetts Department of Public Health
Bureau of Environmental Health Assessment
Emergency Response/Indoor Air Quality Program
October 2003

Background/Introduction

At the request of Ann Rust, Library Director, the Bureau of Environmental Health Assessment (BEHA) conducted an evaluation of the indoor air quality at the Dighton Public Library (DPL) located at 375 Main Street, Dighton, MA. On September 3, 2003, a visit to conduct the assessment was made to this building by Cory Holmes, Environmental Analyst in the Emergency Response/Indoor Air Quality (ER/IAQ) Program. Mr. Holmes was accompanied by Sharon Lee, Environmental Analyst, BEHA and Ms. Rust during the assessment. The assessment was prompted by concerns of symptoms potentially related to mold growth as a result of flooding in the basement.

The DPL is a wood framed building with a cobblestone exterior that was constructed in 1910. The DPL was renovated in 1975. In 1995 the basement was renovated to create a children's library and homework center. The building has a forced hot air heating system and original single-paned sash windows.

Methods

Air tests for carbon dioxide, temperature and relative humidity were taken with the TSI, Q-Trak, IAQ Monitor Model 8551. Moisture content of water damaged gypsum wallboard (GW), wooden trim and baseboard were measured with Delmhorst, BD-2000 Model, Moisture Detector with a Delmhorst Standard Probe.

Results

The DPL has a staff population of 5 with up to 50 members of the public visiting on a daily basis. The tests were taken during normal operations. Test results appear in Table 1.

Discussion

Ventilation

It can be seen from the tables that carbon dioxide levels were below 800 ppm in all occupied areas surveyed, indicating adequate air exchange. The DPL does not have any means of mechanical ventilation but uses windows to introduce fresh air. Occupants reported that many of the windows are difficult to open.

The Massachusetts Building Code requires a minimum ventilation rate of 20 cubic feet per minute (cfm) per occupant of fresh outside air or have openable windows in each room for offices (SBBRS, 1997; BOCA, 1993). The ventilation must be on at all times that the room is occupied. Providing adequate fresh air ventilation with open windows and maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself. It is used as an indicator of the adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the ventilating system is malfunctioning or the design occupancy of the room is being exceeded. When this happens, a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health

Administration (OSHA) standard for carbon dioxide is 5,000 parts per million parts of air (ppm). Workers may be exposed to this level for 40 hours/week, based on a time-weighted average (OSHA, 1997).

The Department of Public Health uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact that the majority of occupants are young and considered to be a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches. For more information concerning carbon dioxide, please see Appendix I.

Temperature measurements ranged from 71^{o} F to 72^{o} F, which were within the BEHA recommended comfort range. The BEHA recommends that indoor air temperatures be maintained in a range of 70^{o} F to 78^{o} F in order to provide for the comfort of building occupants. In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply. Temperature control complaints were reported by library staff. Often times, temperature control is difficult, especially in an old building without a mechanical ventilation system. In addition, spaces were observed around window frames (Picture 1), which can allow drafts to penetrate, leading to temperature/comfort complaints.

The relative humidity measurements in the building ranged from 52 to 63 percent, which were slightly above the BEHA recommended comfort range in some areas, mainly in the children's section of the basement where flooding occurred. The BEHA recommends a comfort range of 40 to 60 percent for indoor air relative humidity. Relative humidity levels in the building would be expected to drop during the winter months due to heating. The sensation of dryness and irritation is common in a low relative humidity environment. Low relative humidity is a very common problem during the heating season in the northeast part of the United States.

Microbial/Moisture Concerns

As previously stated, the basement flooded in July, 2003. Carpeting, GW, wood trim and baseboard had become wet due to water infiltration. Library staff reportedly removed standing water from the carpets using a wet vacuum. No fans or heating units were used to dry moistened building materials. Approximately one week after the flooding incident occurred, a professional cleaning company was contracted to steam clean and treat the carpet with an antifungal agent. Although the carpet was cleaned, library staff reported carpeting underneath bookshelves were not cleaned or dried. The US Environmental Protection Agency and the American Conference of Governmental Industrial Hygienists (ACGIH) recommends that porous materials be dried with fans and heating within 24-48 hours of becoming wet (US EPA, 2001; ACGIH, 1989). If porous materials are not dried within this time frame, mold growth may occur. Water-damaged porous materials cannot be adequately cleaned to remove mold growth. The application of a mildewcide to moldy porous materials is not recommended.

Mold growth was observed on the GW in the homework center, near the floor and in the bulkhead stairwell (Pictures 2 and 3). Mold growth and water damage was noted on wooden baseboard and trim (Picture 4). Like other porous materials, GW that is wetted repeatedly can provide a medium for mold growth. Mold and related particulates can be irritating to sensitive individuals. In order for building materials to support mold growth, a source of moisture is necessary. Identification and elimination of water moistening building materials is necessary to control mold growth. GW with increased moisture content over normal concentrations may indicate the possible presence of mold growth. Identification of the location of GW with increased moisture levels can also provide clues concerning the source of water supporting mold growth. In an effort to ascertain moisture content of GW, samples were taken in areas most likely impacted by water damage, primarily at the base of the wall where mold growth was present. A number of non-effected areas were measured for comparison.

As discussed, water content of GW was measured with a Delmhorst, BD-2000 Model, Moisture Detector with a Delmhorst Standard Probe. The probe was inserted into the surface of walls constructed of GW. The Delmhorst probe is equipped with three lights as visual aids to determine moisture level. Readings, which activate the green light, indicate a sufficiently dry level (0 - 0.5%), those that activate the yellow light indicate borderline conditions (0.5 – 1.0%) and those that activate the red light indicate elevated moisture content (> 1%). Elevated moisture measurements were recorded on GW and on wooden trim in several areas (Table 2).

On previous assessments concerning GW mold growth, BEHA personnel have consulted with Dr. Harriet Burge, formerly the Department Chair, but currently an Adjunct Senior Lecturer on Environmental Microbiology of the Department of Environmental Health at the Harvard School of Public Health. The reoccurrence of mold growth on GW after the application of bleach is common. Bleach consists of sodium hypochlorite in a 5 percent concentration mixed with water. Mold colonization of GW can penetrate through its entire structure. When applied to moldy GW, the water of the bleach solution penetrates into the moldy GW, but the sodium hypochlorite remains on the surface. The sodium hypochlorite disinfects the surface mold that it comes in contact with on the GW surface, but not the mold beneath the surface. The additional water added to the subsurface fuels a spurt in mold growth, which increases mold colonization of the GW. As a result, mold colonies reappear on the surface of treated GW shortly after the application of bleach (personal communication, Burge, 1999).

BEHA staff examined the outside perimeter of the building to identify breaches in the building envelope that could provide a source of water penetration. A number of exterior sources for moisture were identified:

- Damaged/dislodged gutters and downspouts were observed at the rear of the building (Picture 5).
- Heavy moss growth was seen along the front tarmac of the building, indicating an area of chronic water accumulation. The water appears to roll off the peaked roof over the front entrance, which is not equipped with a gutter system (Picture 6).
- The tarmac was cracked and had plant growth between the foundation and tarmac in a number of areas (Picture 11). The growth of roots along exterior walls can hold moisture and eventually lead to cracks and/or fissures in the foundation below ground level.
- The wooden bulkhead located at the rear of the building was damaged (Picture 7 and 8). Spaces were also noted around flashing and in masonry around this

bulkhead, as well as around a metal bulkhead (Picture 9) leading to the carpeted children's library.

- Rotted wooden windowsills and broken windowpanes were seen around the exterior of the building (Picture 10). As previously discussed, spaces around metal window frames, as well as missing/damaged caulking were observed.

These conditions can undermine the integrity of the building envelope and provide a means of water entry by capillary action into the building through exterior walls, foundation concrete and masonry (Lstiburek & Brennan, 2001).

Other Concerns

A number of other conditions that can affect indoor air quality were identified. The library contains a large number of books and flat surfaces that are prone to collecting dust. Dust can be irritating to the eyes, nose and respiratory tract.

Spaces were observed beneath the door to the room in which the oil burner and fuel tank are located. Also noted in this area were holes in the ductwork for the oil burner (Picture 12). These breaches serve as a means of egress for fuel odors, fumes and particulates into the children's library.

An ozone generator was in use in the children's library. The ozone generator was reportedly recommended for use as an air purifier. At this time, no federal government agency has approved the efficacy of ozone as an indoor air cleaner for use in occupied spaces. While ozone may be effective in removing some odors of biological original (e.g. skunk odors), its use as a universal air cleaner has come under question (US EPA, 2003). Ozone is a highly irritating substance to the respiratory system. Until more definitive information becomes available, ozone generators in occupied areas should be used with caution. The generator is equipped with a filter, which appeared to not have been cleaned/changed in some time. To avoid the build-up and re-aerosolization of dirt, dust and particulate matter, filters should be cleaned or changed as per the manufacturer's instructions.

Finally, no local mechanical exhaust ventilation was installed in the restroom. Exhaust ventilation is important in restrooms to remove moisture and to prevent restroom odors from penetrating into adjacent areas.

Conclusions/Recommendations

In view of the findings at the time of the visit, the following recommendations are made:

1. Remove and replace any mold contaminated/water damaged GW and wooden baseboard/trim. This measure will remove actively growing mold colonies that may be present. Remove mold contaminated materials in a manner consistent with recommendations found in "Mold Remediation in Schools and Commercial Buildings" published by the US Environmental Protection Agency (US EPA, 2001). Copies of this document can be downloaded from the US EPA website at: http://www.epa.gov/iaq/molds/mold_remediation.html. Removing the water-damaged GW and wooden trim will also provide maintenance personnel with the opportunity to observe conditions within the wall cavity and determine whether any signs of water penetration through breaches of the building envelope exist.

2. Consider removing basement carpets with replacing an alternative sound attenuating floor tile. Although cleaning has appeared to eliminate microbial growth from the carpet, further growth can be expected to occur once water moistens carpet in below grade areas. To avoid this occurrence, remove carpeting from basement areas where mold was detected prior to the cleaning. If visible mold and/or moisture are present, clean with an appropriate microbiological agent.
3. Consider repairing/replacing damaged wooden window frames to prevent water penetration. Replace broken windowpanes.
4. Repair drainage system shown in Picture 5. Consider installing gutters/downspouts on the main entrance peaked roof to direct rainwater away from the building.
5. Repair breaches in the building envelope including, cracks in walls and tarmac, missing/damaged flashing, and spaces around bulkheads. Consider replacing damaged wooden bulkhead with metal.
6. Consider consulting a building engineer about options to further improve drainage and prevent future flooding of the basement.
7. Keep windows closed during hot, humid weather to maintain indoor temperatures and avoid condensation problems.
8. Clean/change filters for air conditioners and air purifiers as per the manufacturer’s instructions or more frequently if needed.
9. Consider discontinuing use of the ozone generator.

10. Install weather stripping along the top and sides and a door sweep beneath the boiler room door to prevent drafts and odors into the children's area.
11. Seal utility holes and openings in the restroom, as well as in the common wall shared between the boiler room and children's area to eliminate pathways for movement of odors into occupied areas.
12. Seal hole in ductwork for oil burner in Picture 12.
13. Consider installing a local exhaust fan in the restroom to remove excess moisture and odors.
14. Clean and maintain dehumidifiers as per the manufactures instructions.
15. For further building-wide evaluations and advice on maintaining public buildings, see the resource manual and other related indoor air quality documents located on the MDPH's website at http://www.state.ma.us/dph/beha/iaq/iaqhome.htm

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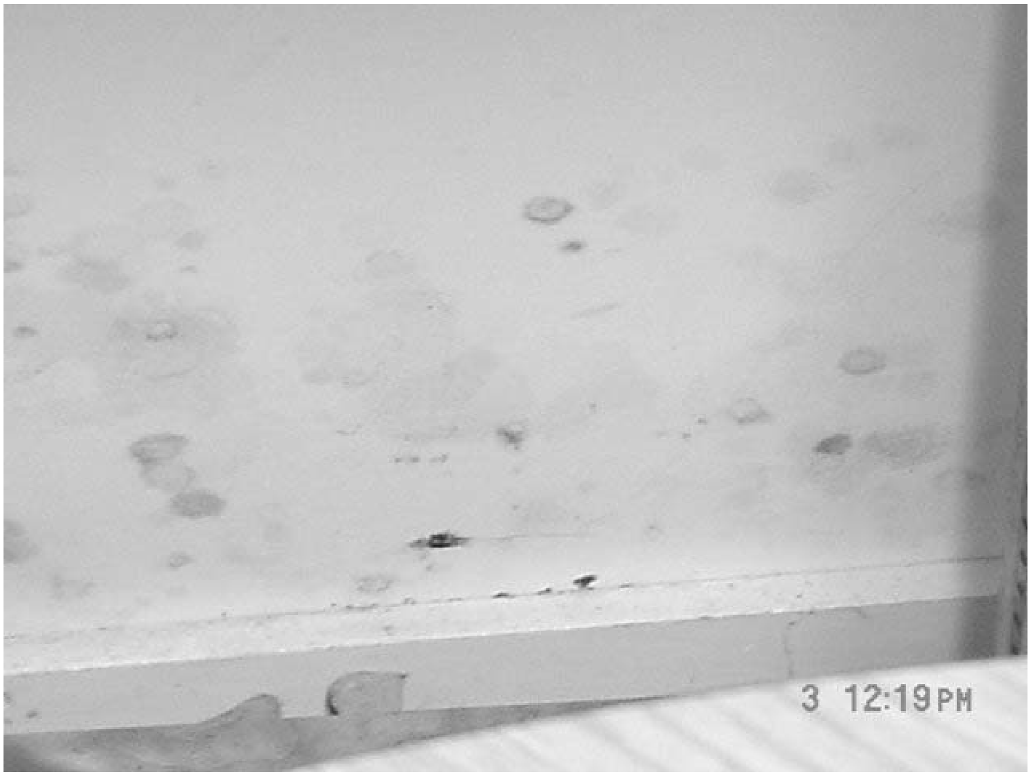
Picture 1

Spaces around Window Frames, Paper Inserted to Show Depth

Picture 2



Mold Colonies (Dark Stains) on GW in Homework Center

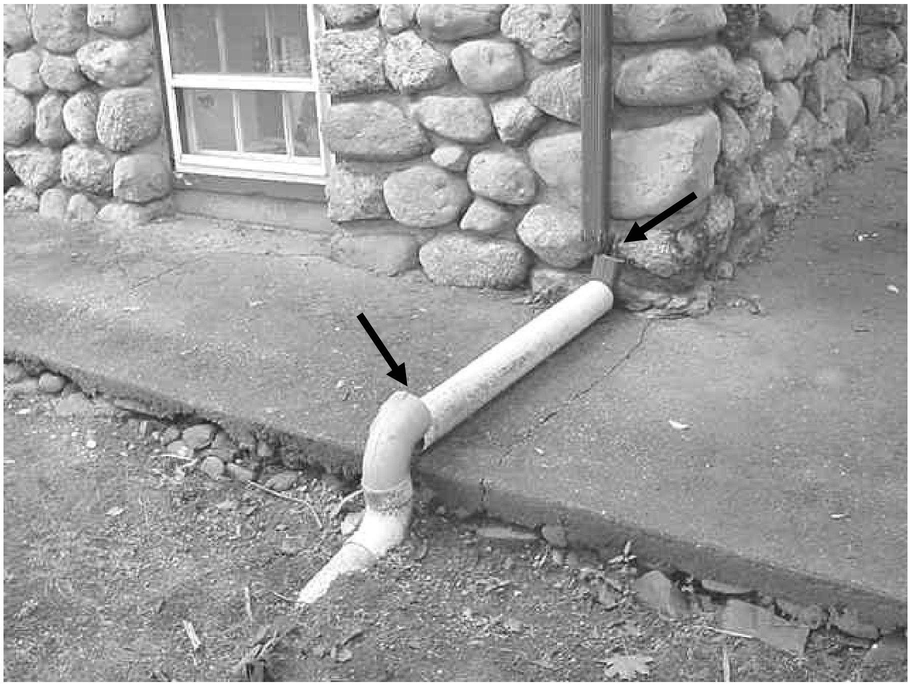
Picture 3

Mold Colonies (Dark Stains) on GW in Bulkhead Stairway in Children's Area

Picture 4

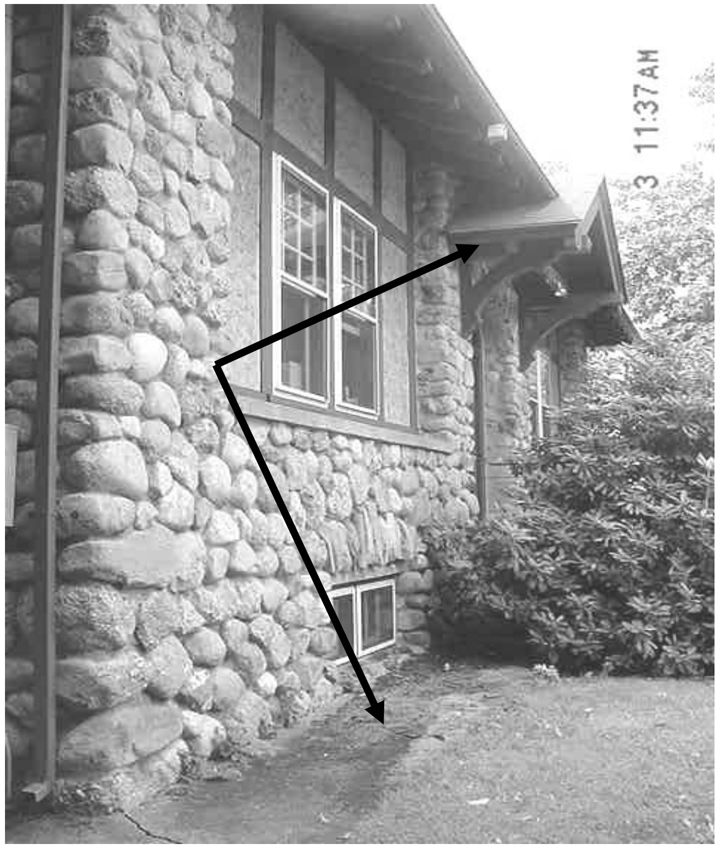
Water Damage/Mold Growth on Wooden Trim and Baseboard in Basement Children's Area

Picture 5



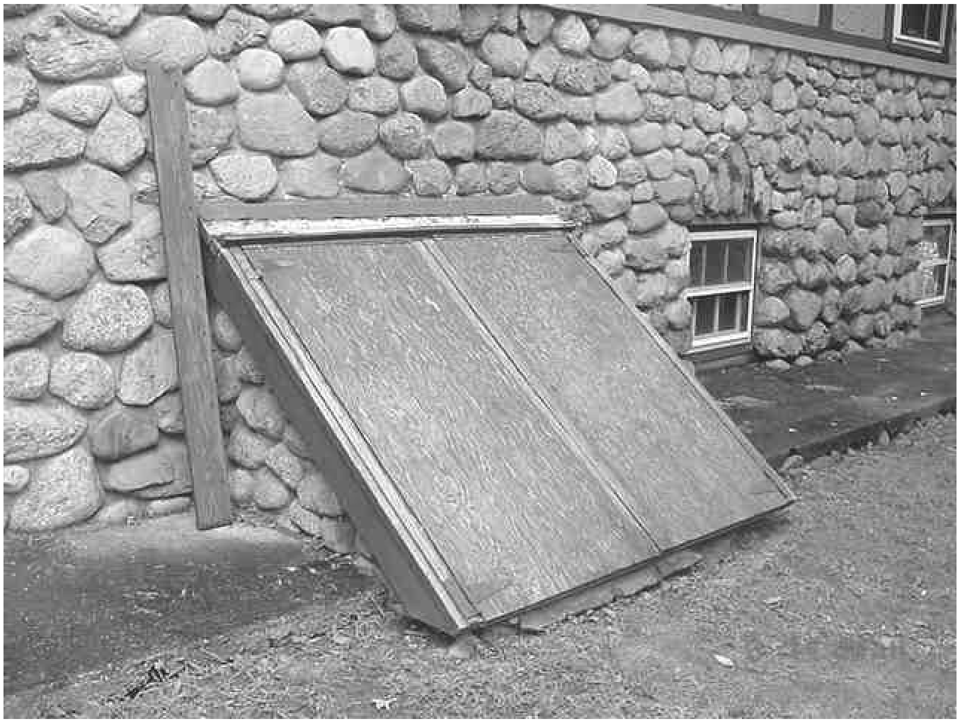
Broken/Dislodged Gutter and Downspout

Picture 6



Area of Heavy Moss Growth below Peaked Roof Without Gutters

Picture 7

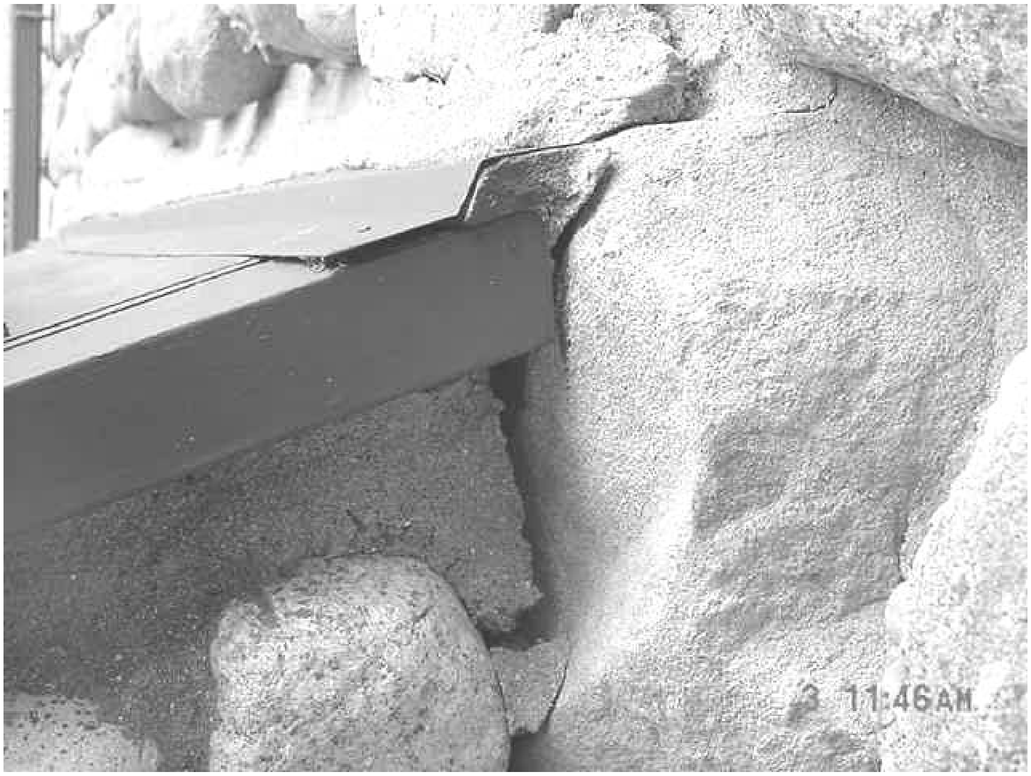


Damaged Wooden Bulkhead, Note Plank against Wall, Which is Part of the Bulkhead

Picture 8

Bulkhead Stairwell Leading to Carpeted Children's Library, Also Site of Mold-Colonized GW in Picture 3

Picture 9



Spaces around Bulkhead Metal Flashing/Masonry

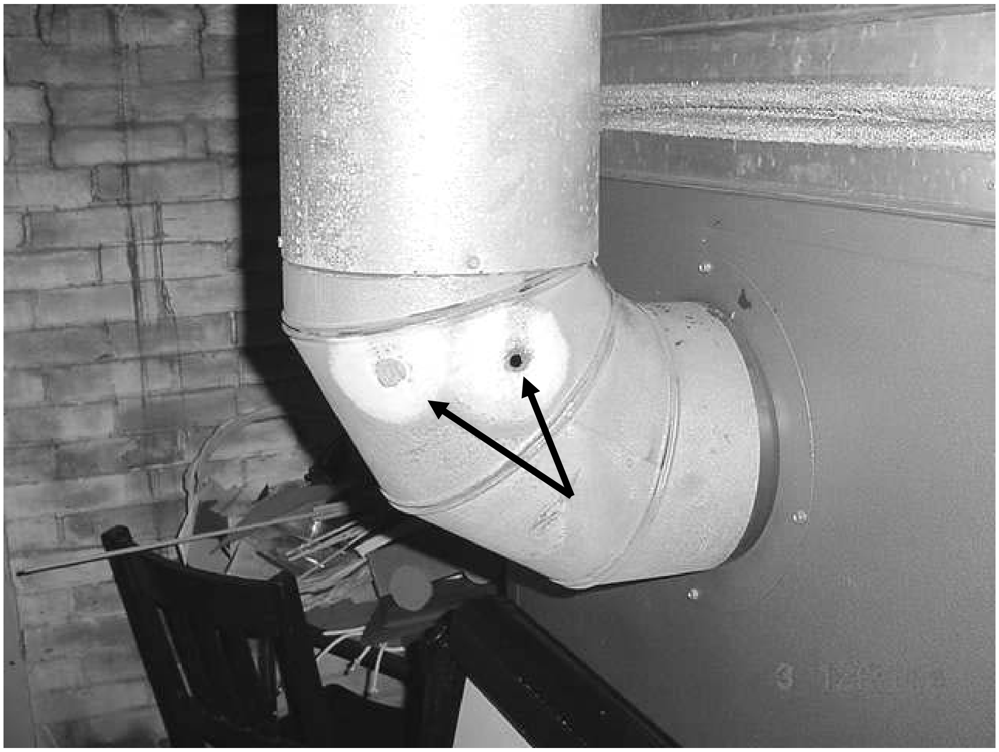
Picture 10

Rotted Wooden Window Frame

Picture 11

Crack in Tarmac/Plants growing between the Foundation and Tarmac

Picture 12



Hole in Ductwork, Note Second Hole Filled

TABLE 1

Indoor Air Test Results – Dighton Public Library, Dighton, MA **Date: September 3, 2003**

Location	Carbon Dioxide (*ppm)	Temp. (°F)	Relative Humidity (%)	Occupants in Room	Windows Openable	Ventilation		Remarks
						Supply	Exhaust	
Outside (Background)	386	71	65					
Storage	703	72	60					Milk cartons and food containers
Boiler Room	483	71	63					Hole in duct
Media	703	72	60		Y			PC computers, window A/C Window open
Office	541	72	59		Y			PC, 2 broken windows
Circulation	501	71	52		Y			Plant on bookcase by window
Stacks	477	71	59		Y			WD ceiling (from old roof leak), window open
Restroom								Open ceiling around pipes
Attic	817	71	58					Storage

ppm = parts per million parts of air
WD = water damage
CT = ceiling tile

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

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						Supply	Exhaust	
Children's Library (Basement)	444	72	63	0	N	N	N	Musty, WD carpet, ozone generator - filter clogged, dusty window will, moist dry wall, WD baseboard and door frame, (25.4 moisture reading) wooden paneled wall warping, metal book cases rusting
Homework Center	465	71	60					Large space in door between boiler room and occupant areas, mold on dry wall base behind stair case, saturated along exterior wall

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Outside Perimeter								Moss growth on concrete skirt around foundation, peaked roof-no gutter/downspouts, moss on roof entrance, plants growing along foundation, rotted wooden window frames-basement, missing/damaged caulking/spaces around windows, flashing around bulkheads damaged, bee/wasps nests on roof ledge (near handicapped access ramp), bat droppings

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